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In the February number will appear:

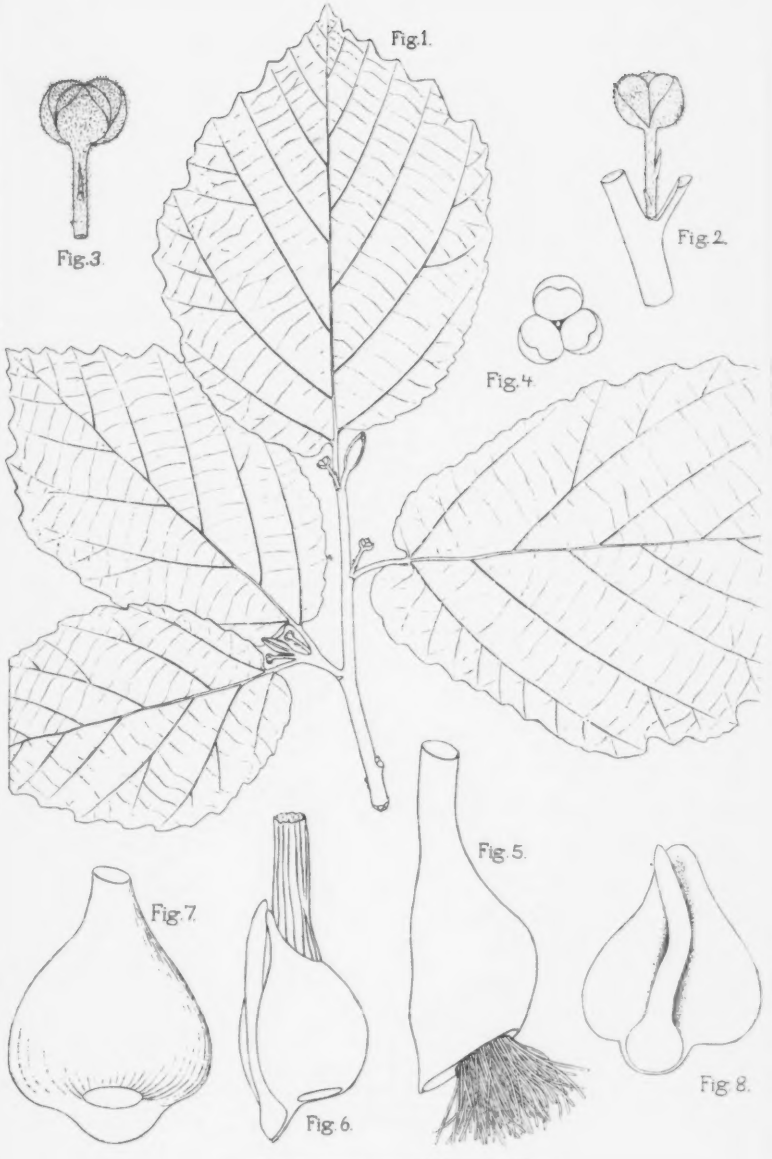
The seed-coats of Malvaceæ, by P. H. ROLFS, Botanist to Florida Agricultural Experiment Station at *Lake City, Fla.*

Cryptomitrium tenerum Aust., by F. STEPHANI, *Leipzig, Germany.*

Evolution in methods of pollination, by Miss ALICE CARTER, *Ithaca, N. Y.*

The flora of Mt. Kataadn, by F. LAMSON-SCRIBNER, Director Agric. Exp. Station, *Knoxville, Tenn.*

Together with the usual shorter articles, reviews of current literature, news, notes, etc.



FOERSTE on FALL BLOSSOMING.

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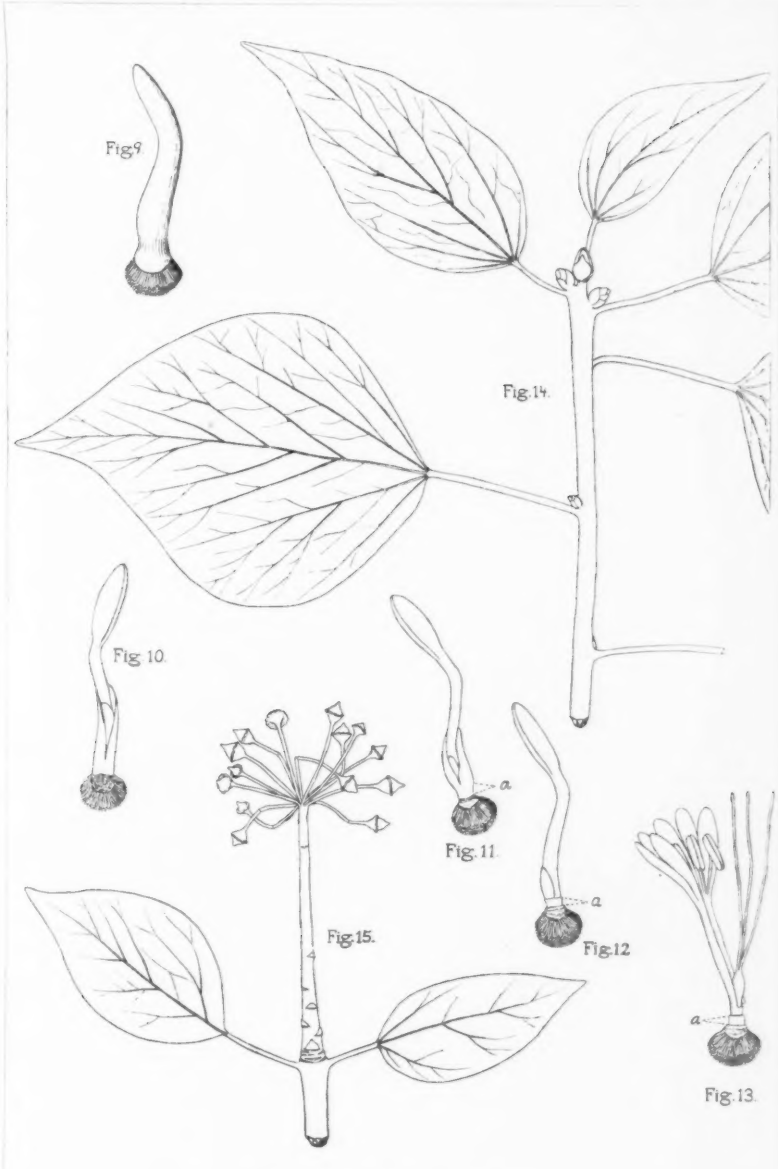

FOERSTE on FALL BLOSSOMING.

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BOTANICAL GAZETTE

JANUARY, 1892.

On the relations of certain fall to spring blossoming plants.

AUG. F. FOERSTE.

(WITH PLATES I AND II.)

Most spring flowering plants in the more northern latitudes begin the development of their floral organs already during the previous year. The following table will give a very good idea of the extent to which this development has taken place in a series of plants collected near Clarendon, Vermont, during the week from the twenty-second to the twenty-eighth of August. In this list are inserted two plants: *Cypripedium parviflorum* Salisb. collected near Ludlow, Vermont, on the twenty-seventh of September, and *Chimaphila maculata* Pursh, found near Andover, New Jersey, on the ninth of October. The first column indicates whether the scaly winter-buds are subterranean (S), subaerial, or chiefly covered with fallen forest leaves or surrounded by moss (SA), or aerial (A). The second column gives the regular flowering season. The third records the length (in millimeters) attained by the flower cluster at the dates when examined. In the case of *Arisaema triphyllum* Torr. the length of the spathes was given instead (S). The fourth column records the size of the largest flower bud in these clusters. In two cases measurements were not recorded (d).

Hepatica acutiloba DC.	S	Mh. Ap.	——	1.50
Thalictrum dioicum L.	S	Ap. My.	2.3	.42
Actæa alba BIGEL.	S	My.	d	d
Actæa spicata, var. rubra MICHX.	S	My.	2.5	.50
Caulophyllum thalictroides MICHX.	S	My.	2.5	.83
Waldsteinia fragarioides TRATT.	SA	Jn.	2.7	2.00
Mitella diphylla L.	S	My. Jn.	.8	.25
Gaylussacia resinosa TORR. & GR.	A	My. Jn.	.8	.17
Vaccinium Pennsylvanicum LAM.	A	My. Jn.	——	1.00
Epigæa repens L.	SA	Ap. My.	7.5	2.50
Pyrola elliptica NUTT.	A	Jn. Jy.	.8	.25
Pyrola secunda L.	A	Jy.	.8	.33
Chimaphila maculata PURSH.	A	Jn. Jy.	.7	.25
Asarum Canadense L.	SA	My. Jn.	——	2.50

Arisæma triphyllum TORR.	S	Ap.	S. 2.5	d
Orchis spectabilis L.	S	My. Jn.	6.3	2.50
Habenaria viridis, var. bracteata REICH	S	Jn.	4.5	2.00
Habenaria orbiculata TORR.	S	Jn. Jy.	4.5	2.00
Goodyera pubescens R. BR.	A	Jn. Jy.	.5	.10
Corallorhiza multiflora NUTT.	S	Jy. Aug.	3.6	1.50
Cypripedium parviflorum SALISB.	S	My. Jn.	——	8.75
Trillium erythrocarpum MICHX.	S	Ap. My.	——	5.50
Clintonia borealis RAF.	S	Jn.	3.0	1.75
Polygonatum biflorum ELL.	S	Ap. My. Jn.	3.0	.75
Smilacina racemosa DESF.	S	My. Jn.	2.5	.33

In Thalictrum dioicum the inflorescence was in a more advanced state of development than the leaves. The inflorescence of Waldsteinia fragarioides lies in the axil of the upper scales of the scaly bud, or of the lowest succeeding leaf. That of Mitella diphylla has a scaly covering of its own, in addition to the scales of the winter bud in general, to which it stands in the relation of a lateral bud. The inflorescence of Gaylussacia resinosa and Vaccinium Pennsylvanicum is found in the terminal and upper axillary buds. That of Pyrola elliptica, Pyrola secunda, Chimaphila maculata, and Goodyera pubescens is enclosed in a scaly bud which usually lies at the center of a cluster of leaves terminating the apparently flowerless stem; occasionally these buds lie in the axil of one of the upper leaves of the flowering stem.

This early development of the flower buds of the next season permits their ready appearance in spring. It will be noticed, however, from the preceding table that even flowers blooming as late as July and August may develop their buds during the previous summer. Occasionally plants mistake the cold winds of the earlier part of October for winter, and the warm, sunny days of Indian summer for spring. In that case the flower buds prepared for the succeeding spring are rapidly developed and perfected, only to be killed off again by the wintry winds of the following months, so that they fail to ripen their seeds. In addition to the list of plants enumerated at other times, the wild strawberry, *Fragaria Virginiana* Ehrh., was very frequently found in blossom this fall, so that thousands of flowering specimens could have been collected.

In quite a number of cases, when the flora of the whole world is drawn under consideration, plants which used to flower in the spring only have taken up the habit of flowering in the late fall, and have succeeded in ripening their seeds in spite of this habit. They were able to flower already in

the fall owing to the advanced state of development of their buds at this season, even before the habit of flowering in the fall set in. It was only necessary to secure means of perfecting their fruit. To illustrate these phenomena the writer has chosen the three plants having this habit which are most familiar to himself: *Hamamelis Virginiana* L. of the United States, *Hedera Helix* L., and *Colchicum autumnale* L., of Europe, a shrub, a vine and an herbaceous plant respectively, belonging to widely different families.

Hamamelis Virginiana, the witch hazel, usually flowers in October or November, but occasionally, after a cold fall, not until the ensuing spring. The flower buds appear very early, almost simultaneously with the leaves, perhaps, but search was not made for them at so early a date. The specimen figured was collected early in July. It will be noticed that the flower clusters are axillary (fig. 1.) The clusters consist usually of three buds closely arranged around the pointed termination of the little axillary stem (fig. 4.) Each bud is subtended by a small appressed bract which reaches about the same height as the buds; these bracts therefore do not offer full protection to the buds within (figs. 2, 3, 4.) Possibly the bracts completely enclosed the clusters formerly, when the witch hazel flowered only in spring. The defect is remedied by the subcoriaceous character of the exposed portions of the calyx, and the hairy covering to both the calyx and the subtending bracts (figs. 2, 3.) The early development of the flower cluster, its long period of extremely slow development, the subcoriaceous character of the calyx and of the bracts, the hairy covering of the same, all indicate rather a plant which once was obliged to protect its blossoms for spring flowering, than a fall plant which is developing into a spring blossomer, or a summer plant becoming a fall blossomer. The fruit remains small during the winter. It is very coriaceous in character, and in addition has a protection of closely-fitting hairs. Its real development begins first in spring, and the seeds are usually not ripened until late summer.

Hedera Helix, the European ivy, usually flowers in October, but in more southern countries as early as September. The writer has seen no record of its ever blossoming in the spring. It may therefore be assumed to be a plant which has entirely gone over from spring to fall blossoming. The young branches of the ivy do not all cease growth at very nearly the same

time, as is the case with so many trees and shrubs, but some of them are terminated with scaly buds, while others continue growth for several months, and may perhaps even have their tips winter-killed. Terminal scaly buds were noticed at Heidelberg, Germany, as early as June 1, although the date of their first appearance is uncertain. They had every character of an aerial scaly bud destined to survive the winter (fig. 14.) Perhaps the scales were a little too green, not at all coriaceous enough, but formerly while the plant was spring blossoming the case might have been different. Not a trace of an inflorescence was noticed in these buds until the first days of July. Near the middle of the month the inflorescence was quite large in all of the flowering buds, and during the last days of July the inflorescence was rapidly pushing its way out of the scaly bud into the open air, and expanding preparatory to fall flowering. The upper scales of the scaly bud are usually carried up on the common peduncle of the inflorescence to a greater or less extent (fig. 15.) The formation of a scaly bud at an early period, at a time when the leaves have almost reached their full growth, and the quite slow gradual development of this bud, are characters perfectly incomprehensible in a summer-flowering plant, taking up the habit of blossoming in the fall, but are readily understood if the plant be supposed to have changed from a spring to a late autumn-flowering plant. The ivy does not ripen its fruit until the ensuing spring. Its character during winter was not noticed.

Colchicum autumnale usually flowers in October, but when the meadows have been inundated in the fall, or when the fall has been unusually cold, it does not blossom until spring. The first trace of a flower was noticed at Heidelberg, Germany, about the middle of July, but it had evidently been in existence for perhaps a week. At the end of the month the flower bud was still minute. The specimen figured belongs to a much later date, just before the flowering season, and represents the developing blossom. As a means of presenting the morphology of this plant it is much better adapted. The bulb has one side considerably flattened, and the other decidedly convex (fig. 5); the lower portion of the bulb slopes obliquely downwards from the convex surface until it meets the flattened surface at an acute angle (fig. 5.) It consists of two withered, brownish scales enclosing the base of

the flowering stem which has developed into a corm. Removing the scales this corm is seen to give form to the bulb (fig. 6.) Along the middle of the flattened face there is seen to be a broad groove, and at its base there has been developed a sort of lobe. To this lobe is attached a bud (fig. 8), which is really in the axil of the inner of the two withered sheathing scales just removed. If at a sufficiently advanced stage of development the thin cuticle at the base of this bud be removed it will be found to completely cover a large bundle of little roots, many of them already 3 mm. long (fig. 9), ready to take the place of the old roots when their work is done (fig. 5.) A reference to the figures will show that by a more rapid development of the tissues just above the roots on the non-attached side of the bud, this bundle of roots becomes central in the oblique base of the future bulb (figs. 5, 7.) The first scale is a closed sheath (fig. 9.) The second scale is a sheath only at its base, but the sheathing portion elongates considerably during subsequent growth (fig. 10.) The first leaf is also slightly sheathing at the base (fig. 11), and the second leaf is not sheathed at all (fig. 12.) In the plant figured the floral envelopes, the stamens, ovary and styles are all already considerably developed (fig. 13.) It will be noticed that a small internode exists between the second scale and the first leaf (*a*, figs. 11, 12, 13.) When the plant begins to flower in the fall the bud pushes its way along the afore-mentioned groove (fig. 8), and up between the withered sheathing scales to the air. This is mainly caused by the growth of the scales of the bud (figs. 9, 10) of the perianth tube, and of the styles of the flower (fig. 13.) The leaves and ovary do not appear until the next spring. At this time the internode between the second scale and the first leaf (*a*, figs. 11, 12, 13) develops rapidly and carries both the leaves and the fruiting ovary out into the open air, thus solving the question of the proper wintering of the fruit. The nondevelopment of the leaves and fruit until the year following the flowering season is certainly not a character such as might be expected from summer flowering plants turning gradually into autumn or spring flowering ones. However, the appearance of the flowers before the leaves is readily intelligible if the reverse change from a spring to a fall blossomer be supposed, since this is not at all an uncommon occurrence in spring flowering plants, and such a forced development of the flower buds before the lower

leaves is often already indicated in the scaly bud of spring flowering plants during the previous year. It is only one of the extreme results of that tendency which certain plants have of flowering as early as possible, and hence of becoming spring and occasionally fall blossoming plants.

Late fall flowering plants may be divided into two classes. First, those which have developed from summer flowering plants by the increase in the number of internodes, with their appendages, or the gradual retardation of growth. Second, those which have developed from spring blossoming plants by the premature development of buds destined to flower first during the ensuing spring. The first class never had any need of protection to the flower buds against wintry weather, and hence should form no scaly buds for the flowers; moreover, since their flowering buds never lay dormant during the winter season, they should show no traces of a period of rest, between the first growth of the flowering buds and their final development. The second class should preserve traces of a scaly bud, and should show traces of great retardation of growth between the first rapid starting of the flower bud and the final rapid completion of the same, as reminiscences of their former almost dormant state during winter. Moreover, the first class should find all their nearest relatives among the summer flowering plants, and the second class should have their nearest relatives among those which flower immediately in the spring. This is the case with the list of fall flowering plants at hand; since, however, this list is only collected from literature, and the writer has not personally examined the plants in a state of nature, a further discussion of the same is omitted for the present.

That spring blossoming plants are the offspring of summer flowering plants, and that they have obtained the power of flowering so early by decreasing the number of their internodes and by starting the development of their flower buds during the previous year is a well known fact. This is further indicated by the fact that spring plants grade by intermediate species into early and late summer flowering plants. If there are related species flowering in the fall, and they belong to the first class above described, a series of intermediate early and late summer flowering plants is sure to be observed. If a spring flowering plant has close relatives among fall blossomers, and none whatever during the inter-

mediate summer months, the development of the fall flowering species from those blooming in spring, in the manner described above, is very likely to be the case. As a matter of fact, most fall blossoming plants belong to the first class.

The ideal time for the flowering season of plants is in late spring and early summer. In the struggle in the race for existence two tendencies set in. The one is to secure advantage over surrounding plants by increasing in size and thus securing more light, air and room for the development of their own flowers. This tends to result in late summer and in autumn flowering plants. The other is to gain advantage over other plants by the earlier blossoming of their flowers, or by blossoming before the foliage of the trees overhead, or that of the surrounding plants can cut off the light or otherwise interfere with their development. This tends to produce spring flowering plants. Autumn blossoming plants, which are the result of the extreme development of the latter principle, are in one sense of the term freaks of nature. The writer believes, however, from a study of the literature of the flowering seasons of plants, that this freak of fall flowering has become a permanent one for a greater number of plants than botanists usually suppose, and that there should be recognized a distinct division of fall flowering plants whose nearest relatives are with those that blossom in the spring.

If the principle that spring flowering plants are produced from summer flowering plants by the reduction of their internodes, be kept in view, it is evident that this result might be attained through the struggle for light and room *in situ*. The same result would be attained if summer plants should migrate temporarily toward the north, or up mountain sides, since the shortening of the period favorable for vegetation might operate in reducing the number of internodes and in hastening the perfection of the flowering buds, while after these alterations had become permanent, a return to more congenial climates would favor earlier, possibly spring blossoming. Essentially the same conditions would exist *in situ*, if the colder climate of a glacial period should come down from the north. The reduction of the period favorable for floral development would again operate in reducing internodes and in hastening the development of floral buds. The retreat of glacial climate would favor earlier blossoming, in many cases spring blossoming. Plants which were spring blossomers in the far

north before the advance of the glacial climate might be forced during its advance to migrate southward to maintain their existence, and on the retreat of the same might climb up the mountain sides and remain there as witnesses of their former migration. Moreover, plants which formerly had been spring blossomers might during the advance of glacial climate maintain themselves *in situ*, by adapting themselves to the more rigorous climate. On the retreat of the glacial conditions they might have so altered their habits as to be able to maintain their existence only on mountain tops or in the distant north. Migration to these places would therefore set in. It is probable that all these causes have operated in the production of spring blossoming plants. It is impossible to tell in the case of individual plants, to which method their production is to be ascribed. It is sufficient for the present to remember that nature has many means of accomplishing the same result.

Heidelberg, Germany.

The effect of mechanical movement upon the growth of certain lower organisms.

H. L. RUSSELL.

The effect of external agencies upon the growth of organisms has been thoroughly studied in several of its relations. Of these influences, the relation of temperature to growth, is perhaps the best understood. Other factors, such as the effect of light, of increased and diminished pressure, have also been made the subject of more or less careful study.

To the effect of mechanical movement upon the growth, less attention has been given, nor have the results already obtained been entirely in harmony with one another.

In the following experiments an attempt has been made to find out, (1) what influence mechanical movement has upon growth of cells in regard to size and form; (2) its influence upon growth in regard to increase in number.

The method used in the experiments was as follows:

Two 500 c. c. distilling flasks were half filled with nutrient solutions, sterilized and then inoculated with a small quantity of the germ to be studied. After thoroughly distributing the

inoculated "seed" by shaking, a number of samples were taken and from these the number of cells in a certain volume was determined by means of Nachet's hæmacytometer. By means of this apparatus equal known quantities were used each time. A number of counts, usually not less than one hundred, were made, so as to make the average as accurate as possible. At first each flask was inoculated and counted separately, but it was soon found that more accurate results could be secured by determining the number present per unit of volume for the whole amount of the fluid and then dividing it into two equal amounts. The danger of contamination from outside influences is of less consequence than the difference in units of volume which inevitably occurs where the determinations are made separately of the amount of "seed" added to each flask. After counting, the two flasks were subjected to exactly the same conditions, with the exception that one of them was kept in a state of constant agitation.

This was secured by the rotation of a vertical shaft to which was attached a horizontal bar. This bar in its rotation struck and lifted the flask, which on its return swing struck against an upright standard. The stroke by the rotating bar and the sudden checking of the movement of the flask kept the fluid in a state of constant agitation. All points of contact of the flask with the bar and standard were sheathed with rubber to prevent breaking. The power was furnished by a small reaction water wheel and was transmitted by a belt from a pulley on the motor to a cone pulley fastened to the upright revolving shaft. This cone pulley enabled me to vary the rapidity of the revolution of the horizontal arm at pleasure.

After allowing a certain time for growth, samples were withdrawn and counted in the same way as before. The number per unit of volume at the close of the experiment divided by the number per unit of volume inoculated as "seed" gives the ratio of increase for each flask. As a check, the solution was sometimes filtered and the organic substance carefully collected, dried, weighed, and the ratio thus determined. For this, the ash constituent of the cells can be neglected without interfering materially with the accuracy of the results.

In the majority of the experiments, *Monilia candida*, a yeast-like germ capable of inducing alcoholic fermentation in most sugar solutions, was used for the tests. Two other

germs, *Oidium albicans* and *Saccharomyces mycoderma*, were also used in various cases to confirm results.

To determine the effect of movement upon the size and form of the cells, an experiment was made with Oidium albicans in a bouillon culture. This germ when grown in this culture medium in the ordinary way forms two types of cells, one of which is a long, slender, hypha-like filament, and the other, a short, oval, or oblong yeast-like cell. As a rule, the growth mass is more or less gelatinous, the jelly-like consistency being due to the intimate intermingling of the elongated cell type. Where the short type of cells prevail, the vegetative mass in the bottom of the flask is of a more sandy nature. Two flasks were inoculated with this germ and subjected to similiar conditions except that one of them was kept in a state of constant movement while the other was left undisturbed.

The results obtained were as follows: in the still flask, the two types of cell structure were present in the usual proportions, and a wide variation was found in the yeast-like cells. These varied from 4×8 μ wide to 7×14 μ long. In the shaken flask no true hyphal filaments were found, such as were present in ordinary cultures. The nearest approach to true filaments were several chains of 4–6 slightly lengthened cells. The cell-contents did not differ materially in samples taken from each flask.

Much less variation in size was found among the cells of the shaken flask than in the other one.

The experiment was repeated with Saccharomyces mycoderma, a mycelium-building yeast. With this germ, the time of incubation was extended until quite a thick veil or membrane had formed over the surface. The still flask showed two types; one a submerged form, slender in outline, about 0.85×2.25 μ, and the other a surface form with vacuolated contents and plumper outline, averaging 1.2×2.5 μ. In the flask which was kept in motion there was a greater variation found in size, but that was owing to the large number of young daughter cells that had broken away from the mother cells before maturity. The mature cells were quite uniform in size, broadly oval in form, and almost all highly vacuolated. The average size was 1.25×2.25 μ.

From the above experiments it would seem, first, that incessant movement tends to prevent the formation of true hyphal filaments, although elongated types of cells are found;

second, that with the germs forming torula-like cells but little difference in size and shape can be produced. What difference there is seems to be caused not so much by the agitation of the fluid as by the exposure of the cells more freely to the influence of the atmosphere. When submerged the cells grow slender, with homogeneous contents, while the surface-grown forms were highly vacuolated and more broadly oval. The cells from the shaken flask agree in all essentials with those grown at the surface of the still flask, except that they averaged somewhat larger in size.

The second series of experiments bears upon the influence of mechanical movement upon the increase of cells. Horvath[1] conducted a series of experiments upon bacteria and their relation to movement, in which he found that mechanical movement interfered materially with the growth of the germs. From this he made the sweeping generalization that movement had a retarding influence on the growth of all lower organisms. Hansen[2] investigated the subject in connection with his work on yeast (*Saccharomyces cerevisiæ*) and found the reverse to be true. The germs increased two to three times faster when agitated than they did when grown at rest. He concluded that it was the agitation of the cell itself, aided possibly by the more minute subdivision of the nutritive materials, that enabled it to increase more rapidly. The introduction of air into the fluid by the apparatus he used was so little that he thought this point was not of much importance.[3]

In the following synopsis of results, A in all cases represents the culture agitated and B the one that grew undisturbed.

NO. OF EXP.	KIND OF GERM.	HOURS OF GROWTH.	NO. OF GERMS PER UNIT OF VOLUME.		PROPORTION SHOWING RELATIVE INCREASE IN NO. OF CELLS.	RATIO BETWEEN A AND B.
			BEFORE EXP.	AFTER EXP.		
A_I.	Monilia candida.	94	16.9+	2332	1:138	1.45+
B_I.				1618	1: 95	
A_{II}.	Oidium albicans.	48	4.67+	1262	1:270	2.0+
B_{II}.				610	1:130	
A_{III}.	Monilia candida.	70	24.4+	1087	1: 44+	1.41+
B_{III}.				767	1: 31+	

[1] Horvath: Pfluger's Archiv f. d. ges. Phys. XVII, 125.
[2] Hansen: Medd. fra Carls. Lab., I, 271.
[3] Hansen: Hypothèse de Horvath, Medd. f. Carls. Lab., I, 96, French résumé.

The culture solution used in all cases was a 10 per cent. solution of grape sugar to which 1 per cent. peptone had been added. The above results indicate without exception that those germs which were agitated increased from 1.4–2 times as fast as those grown undisturbed. As a check upon the counting process, determinations of the dry matter present were made by chemical analysis at first.

Exp. III, which showed a ratio between A and B of 1.41 by the counting process gave by chemical analysis the following result. Amount of organic matter formed in A_{III} 0.1778 gm.; in B_{III} 0.1293 gm. Ratio between A and B 1.37+. This proves that the counting process is reasonably exact as it agrees quite closely with the chemical analysis. This is only true however where there is general uniformity in size of the cells.

The amount of alcohol which was produced by this germ when subjected to these different conditions, was also determined in a number of cases. In every case where this was made, a considerable increase in amount of alcohol formed was found in the undisturbed culture (B) over the agitated culture (A). It would seem then that agitation exerts a favorable influence upon the formation of cells but a retarding effect upon the products of fermentation. Both of these processes, growth and fermentation, depend directly upon the kinetic energy of the plant organism. Where katabolic processes are manifested more strongly in fermentative action there seems to be less energy used by the plant in growth. The data of the two following experiments with Monilia candida, giving the highest and lowest proportions found by analyses, illustrate this point.

NO. OF EXP.	ALCOHOL FORMED.	INCREASED GROWTH OF SINGLE CELL.	RATIO.
A_V	1.6%	335	
B_V	3.2%	109	
Proportion.	1 : 2 :: 3.07 : 1		6.14
A_{VI}	3.2%	44	
B_{VI}	3.8%	31	
Proportion.	1 : 1.18 :: 1.41 : 1		1.66

It will be noted that while no uniformity seems to exist in the ratio, the *amount* of *fermentation products* of the cells in B is *always* greater than in A, while the *amount of organic matter* formed stands in an inverse relation.

We may now ask what is the cause of this increased rapidity of growth when agitated. The experiments detailed above allowed considerable aeration during the movement and as this factor seemed most prominent, the experiments were repeated in such a way as to increase the aeration and diminish as much as possible the movement of the fluid. If aeration increases the growth of the organisms, there should be an increase in the ratio between A and B.

Exp. I. An Esmarch's coiled glass tube, such as is used in bacteriology for air determination in fluid cultures, was inoculated with Monilia candida and air drawn slowly through the coil by the aid of an aspirator. The small bubbles of filtered air slowly travel the spiral, so that a considerable quantity of oxygen ought to be absorbed by the liquid. In this way aeration is considerably increased while the movement of the fluid is much reduced. At the end of 42 hours growth, it was found that the germs which were aerated had increased 2.5 times as fast as the non-aerated culture.

Exp. II. A 500 c.c flask was partially filled with a nutrient solution and inoculated with freshly grown Monilia candida. The mouth of the flask was closed by a triple-perforated sterilized rubber cork. In two of the openings, glass tubes were inserted and the lower ends were drawn out into fine points. The third opening was closed by a bent open tube, the outer end of which was directed downwards. These glass tubes were closed with cotton-plugs and sterilized before being put in place. The two capillary tubes were connected to the blast of a filter pump and thus a stream of filtered air was forced into the fluid culture. The fine bubbles of air rising to the top of the fluid escaped through the bent exit tube. In 30 hours there was found to be 2.2 times as many cells per unit of volume in aerated flask as there were in non-aerated.

Exp. III. In both of the preceding experiments aeration was increased as much as possible while the movement was lessened. In this experiment the reverse order was followed. A thick glass tube was sealed at one end and at 5 cm. distance from this end, a large bulb capable of holding 300 cc.

was blown. In this culture bulb was placed some coarse sterilized quartz sand. The longer open arm was closed with cotton. The vessel was filled with culture fluid so that the bulb and a portion of the open arm was entirely filled. This apparatus was connected with the motor and so arranged that it revolved in as nearly a horizontal position as possible. The coarse sand inside acted as a distributor of the motion to the fluid causing it to be agitated thoroughly.

In this way the maximum movement was obtained with a minimum of aeration; the only chance for aeration being through the small opening of the open arm. Cultures of Monilia candida grown for forty hours and treated in this way had 1.4 times as many cells as those grown in undisturbed flasks.

It is practically impossible to get a considerable movement of the liquid without more or less aeration and the converse is equally true, but where aeration was increased in greater proportion than movement, as in Exp. I and II, we find the percentage of increase of cells and consequently of organic material to be much greater than in Exp. III, where aeration was diminished relatively more than movement.

This factor of aeration seems to be the predominant one although it is possible that the increase is not due to the action of any one factor alone. More intimate division of nutritive materials and the constant presentation of fresh food material to the surface of the plant cell probably aids in the increased growth.

Summing up the points discussed into concluding sentences, we may say that:

1. The form and size of fungal cells is but little influenced except in the case of hyphal filaments which seem to form with difficulty when subject to constant movement.

2. Constant agitation affects very strongly the increase in number of cells formed and consequently the amount of organic matter produced. The increase by growth in agitated cultures as compared with still-grown cultures ranges between wide limits but is usually 200–300 per cent.

3. The amount of fermentation products, as determined by the alcohol formed, seems to stand in an inverse ratio. All cultures so tested showed uniformly less alcohol in agitated than still cultures.

4. The cause of this more rapid cell-multiplication by mechanical movement seems to depend upon aeration of the

culture, the cells growing more rapidly in contact with atmospheric oxygen than when submerged.

5. While this appears to be the chief factor, other elements such as better conditions of nutrition, etc., probably enter in as less important factors.

These researches were carried on in the biological laboratories of the University of Wisconsin.

Baltimore, Md.

Noteworthy anatomical and physiological researches.

Apical areas in seed plants.

The copious researches of MM. Van Tieghem and Douliot[1] on the origin of endogenous members in the vascular plants, published in the *Annales des Sciences Naturelles Botanique* during 1888, will be remembered by all students of contemporary botanical literature. The conclusions arrived at regarding the apical cells of monocotyledons and the single apical cell of the Archispermæ (gymosperms) are well known, having already found their way into at least one of the more prominent text-books. It is by no means universally admitted, however, that the proof of apical cells in these groups of plants is decisive. The older literature on the subject was given in résumé by Dingler[2] in 1882, but since that time the important works of Karsten,[3] DeKlercher,[4] Groom,[5] Korschelt,[6] and others have appeared, supplementing the classic researches of Strasburger, Hanstein, Hofmeister, and the rest. In the *Ann. des Sciences Nat. Botanique*, 1890, Douliot[7] reviews the later works and, adding some investigations of his own, maintains the positions advanced in 1888 in his paper in conjunction with Van Tieghem. In brief, his conclusions are as follows:

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[1] Recherches comparatives sur l'origines des membres endogènes, Ann. Sci. Nat. Botan., VII. VIII. 1. (1888.)

[2] Ueber das Scheitelwachsthum des Gymnospermen-Stammes, München, 1882.

[3] Ueber die Anlage seitlicher Organe bei den Pflanzen, Leipzig, 1886.

[4] Sur l'anatomie et le développement du Ceratophyllum, Bihang, k. Sv. Vet. Acad. Hand. IX, Stockholm, 1885.

[5] Ueber den Vegetationspunkt der Phanerogamen, Ber. der deutsch. bot. Gesell. 1885.

[6] Zur Frage über das Scheitelwachsthums bei den Phanerogamen, Pringsh. Jahrb. wiss. Bot. 1884.

[7] Sur la croissance terminale de la tige, Ann. Sci. Nat. Botan. VII, XI. 283.

(1). In the twenty genera of gymnosperms which have been studied the uniform presence of a single apical cell at the summit of the growing stem has been demonstrated. This cell, as in the lower vascular Archegoniata, is sometimes pyramidal, sometimes prismatic, but always solitary. Here is the diagnostic anatomical character of the Gymnospermæ. They are, by it alone, sharply discriminated from the rest of the seed-plant phylum.

(2). In the monocotyledons there are two categories to be distinguished; first where there are three initial cells at the apex of the stem from which all the others are derived, as in Phragmites, Tradescantia, Zea, Asparagus, Polygonatum, Canna and others; and second, where there are but two, as in the Naiadaceæ, Potamogetonaceæ, Juncaceæ, Alismaceæ and Hydrocharidaceæ. The latter case is the more frequent.

(3). In the great majority of the dicotyledons the stem is terminated by three apical or initial cells. In a small number, principally in the the apetalous division of the Archichlamydeæ, there are only two initials, and in this case one initial cell is common to the dermatogen and plerome layers of Hanstein, but in the other and more common case each embryonic layer has its own peculiar initial cell. In the Gamopetalæ (Metachlamydeæ) there are three initials, so far as the investigations have gone.

It is thus seen that, in addition to a clearly functional archegonium or egg-organ, the Archispermæ (Gymnospermæ) are distinguished from the Metaspermæ (Angiospermæ) by the presence of a single apical cell. Thus evidence seems to be accumulating in favor of the classification, long ago proposed, which would include the Coniferæ, Cycadeæ and Gnetaceæ with the Pteridophyta, Bryophyta and Characeæ (and possibly the Coleochaeteæ) under the Archegoniatæ—those plants with a functional egg-organ. The Metaspermæ are sharply distinguished by the abortion of the egg-organ while the Thallophyta are as clearly discriminated by the absence or rudimentary condition of the egg-organ. In addition to these characters the Metaspermæ are the only plants which develop their epidermis independently from a definite proto-epidermal meristem cell. This character seems to be an important one from a phylogenetic point of view and gives color to any plan which proposes to recognise the great affinity between the heterosporous Filicneæ and Lycopodineæ, re-

spectively, and the Cycadeæ and Coniferæ. In this connection one can not but deplore that in some quarters American botany has not yet freed itself from the altogether obsolete notion that the Coniferæ should be placed between the monocotyledons and the dicotyledons. — CONWAY MACMILLAN.

Effects of parasitism of Ustilago antherarum Fries.[1]

Ustilago antherarum is included by Saccardo[2] under *U. violacea* (Pers.) Fckl. and is well known as parasitic in the anthers and ovaries of Silene, Lychnis, Saponaria, Pinguicula, Stellaria and other allied plants. By the growth of the fungus, what has been termed by A. Giard "parasitic castration of the anthers" takes place. There is, however, a hypertrophic development of the anther and in the diclinous flowers of Lychnis, which have in common with other such flowers rudiments of the undeveloped sporangia — this hypertrophy suffices to give the flower a monoclinous appearance. Under the irritation of the parasite the rudimentary anthers in pistillate Lychnis flowers are stimulated to develop, but the tapetal and archesporial layers of the thecæ are supplanted by the fungus mycelium and subsequent growth of spores. For a considerable time the Ustilago plant develops by a kind of symbiosis with the cells of the host. This goes so far that the anther walls are, in normally pistillate Lychnis flowers, stimulated to form the typical layers by which the ordinary dehiscence is brought about. Thus the Ustilago spores are scattered from the hypertrophic anthers of Lychnis precisely as if they were normal pollen spores. A corresponding and attendant atrophy of the pistil will be observed in most cases, and it is the nutritive stream which properly should go toward the pistil, that is diverted toward the hypertrophic anthers. And furthermore the various accessory characters of the staminate flower are developed in proper order under this parasitic stimulation, so that the normally pistillate but apparently staminate flower presents the appearance of pollen-bearing to such an extent that it is doubtless visited by those insects which habitually transfer pollen from the staminate flower to the stigma of the pistillate. Now as the Ustilago spores are developed in lieu of pollen spores and make their

[1] Vuillemin: Sur les effets du parasitism de l'Ustilago antherarum, Comptes Rendus Hebd. CXIII. 662. (1891.)

[2] Sylloge Fungorum VII. 574.

appearance in a hypertrophic rudimentary anther which under their stimulation, forms the ordinary dehiscence lines, it happens that when the spores of the Ustilago are ripe, they are distributed by the same means and agencies which commonly distribute the Lychnis pollen. This is of clear advantage to the fungus for it is thus sown upon young buds as well as upon stigmatic areas. The whole series of phenomena is one which indicates in very interesting fashion how intimate and remarkable may be the relation between host and parasite.—CONWAY MACMILLAN.

The behavior of the pollen-tube of gymnosperms.

In a recent paper,[1] preliminary to a more complete research Belajeff publishes some suggestive observations regarding the divisions which take place in the pollen-tube of *Taxus baccata*.

It is well known that one or more cells are commonly cut off from the body of the pollen grain early in its development. Many have considered this cell or cells as representing a male prothallium, and Strasburger states that they have to do with the formation of the pollen tube, and after that have no further part to play. Belajeff, however, was led by his researches into the antheridia of the higher cryptogams and the pollen tubes of the angiosperms to think that it was not the large cell of the pollen grain of gymnosperms, but the small ones which have to do with fertilization. He therefore examined with great care the processes in Taxus baccata with the following result:

In this plant the contents of the pollen grain divides into two cells one large and one small. The larger one, *a*, produces the tube, the nucleus and other contents wandering to the apex. The smaller cell *b*, which remains behind, then divides into two by a partition transverse to the axis of the tube. The anterior of these two, *b'* then wanders toward the apex of the tube while the posterior *b*," becomes disorganized. Its nucleus however also wanders toward the apex, usually passing the anterior cell. The apex of the pollen tube now increases in size considerably as does also the cell *b'*. The nucleus of this now divides into two, one spherical, and the other lenticular. When fertilization occurs the wall of the pollen tube and the very delicate wall of the cell *b'* disappears and the

[1] Berichte der deutschen bot. Gesellschaft IX. 280. (1891.)

spherical nucleus of *b'* fuses with the nucleus of the egg cell of the archegonium.

While it is hardly safe to generalize from such limited observations (for so far they have been confirmed only on Juniperus and that but partially) nevertheless the observations accord much better with what we should expect from analogy with lower and higher plants. If these observations are confirmed by more extended study the pollen tube must be looked upon as the prothallium, while the small cells constitute the antheridium. The one which travels to the apex of the tube must be the mother cell of an antherozoid, to which the spherical nucleus would correspond. Perhaps on account of the imperfect division of *b'* it would have to be considered as more primitive still, being the homologue of the cells from which the antherozoid mother-cells arise.—R.

BRIEFER ARTICLES.

Notes on pollination.— I. The sandy hills, old trees and fences on the north shore of Long Island are covered with *Ampelopsis quinquefolia* Michx. The numerous small, greenish-yellow flowers are quite conspicuous in contrast with their background of green leaves. On the morning of July 22d, there were twenty-two flowers open on one cyme, the pollen-covered stamens outspread, the erect stigma occupying the flower center. Numerous visitors — honey bees, humble-bees, hornets, Sphecidæ, other Hymenoptera small and large, and Diptera — were either sucking the nectar which is exposed in the base of the flower and accessible to the shortest tongues, or collecting or eating the pollen. Almost all of them touched both stamens and stigma before leaving a flower. Early in the afternoon of the same day stamens and petals had fallen from all of these flowers but the visitors continued their visits as industriously as ever — of course, now only sucking nectar.

On the morning of July 23d, no more flowers had opened, and there were none with stamens on this whole plant or on any of the plants near by. The number of visitors was diminished. Early in the afternoon many new flowers had opened on all the plants and insects abounded. July 24th, at 8 A. M., after a heavy rain, very few stamens and petals remained. At 11 A. M. there were many newly opened flowers. July 25th, at 2 P. M., no stamens.

The stigmas appear to remain receptive for some days and the older flowers which contain them alone are visited as often as the freshly opened ones. Self-pollination, which would be easily accomplished, is only possible in the few hours during which the stamens last and even then, owing to the great number of visitors, cross-pollination seems much more probable in pleasant weather.

II. The species of *Trillium* have, so far as I know, been studied with reference to their pollination only by Loew, whose meager notes on imported plants are recorded in Pringsheim's Jahrbücher, vol. XXIII, p. 238.

Four species are grown in the Botanical Garden at South Hadley, Mass., as nearly as possible under natural conditions.

1. The very inconspicuous, dull reddish-brown flowers of *T. sessile* L. are erect "in the bosom of the leaves." The stamens closely surround the stigma. Self-pollination seems inevitable. There is no honey. No visitors were seen though the flowers were watched at intervals each day during their period of flowering. Loew reports one pollen-eating beetle.

2. *Trillium erectum* L. The rather large, brown-red flowers are abundant and rather conspicuous in the Massachusetts woods in early spring. Their strong, disagreeable odor may perhaps attract carrion-loving flies or beetles. Unfortunately I could not watch the flowers in the woods and there were only a few in the garden. Stigmas and anthers stand at nearly the same level, freely exposed in the flower-center by the recurving of sepals and petals. There is no honey and for many days no visitors appeared. Finally four Coleoptera came in one day, apparently to eat the stamens—certainly of little avail in cross-pollination and probably too late to be of use in any case. Spontaneous self-pollination seems to be the rule here too.

3. One morning, some time after the blossoms had all disappeared, a humble-bee flying by me vanished under the leaves of the blood-root bed and continued his buzzing there so contentedly that it was evident treasure had been found. Following him, and pushing aside the large leaves of the blood-root, I found, concealed under these leaves and their own too, the nodding flowers of *Trillium cernuum* L., well hidden from human view but recognized from afar by the keen senses of their lover. He was busily at work sucking nectar which was afterwards seen in small drops at the ovary base, between the ovary and the bases of the filaments opposite the inner perianth leaves. This species is slightly proterandrous, the stamens dehiscing before the petals are outspread and while the stigmas are still close together. After the nodding flower has fully opened self-pollination is easy, the recurving stigmas being just below the pollen-covered anthers.

4. *T. grandiflorum* Salisb. In the first stage, the mouth of the flower is closed by the anthers. Later, the petals expand further, the stamens separate above and the stigmas appear between them, in the flower-center. A little nectar secreted by the "septal glands" lies between the ovary and filaments as in the preceding species. Hive bees occasionally collect the pollen. The stigmas recurving to meet the stamens may be self-pollinated in the absence of visitors.

III. *Oakesia sessilifolia* Wats., *Uvularia perfoliata* L., *Clintonia borealis* Raf., are visited abundantly by humble bees for the nectar contained in the hollowed bases of the perianth-leaves.

IV. While watching the pollination of Asters and Solidagos this fall, I was surprised to find large numbers of humble-bees, honey-bees, wasps, and other large and small Hymenoptera, flies — notably Syrphidæ, beetles and four species of Lepidoptera, visiting *Solidago squarrosa* whose flowers were all withered, to suck the nectar secreted by the involucral bracts. This is another of the cases of the occurrence of the extra floral nectar whose use, if any, to this plant has yet to be discovered.

An article in the *Biologisches Centralblatt* (vol. VIII, p. 577) may shed some light on the use of these extra-floral nectaries. It is in substance this:

Von Wettstein has observed the accumulation of nectar on the involucral scales of *Jurinea mollis*, *Serratula lycopifolia*, *S. centauroides*, *Centaurea alpina*, &c.

In *Jurinea* the secretion begins when the head has attained one-fourth of its full development: it ceases when the first flowers unfold. It begins each day directly after sunrise, increases until about 8 o'clock and then commonly diminishes until evening. Even before sun rise one may find ants sitting motionless upon the buds; as soon as the nectar-secretion begins they seek most eagerly for the places on the scales at which it appears. Of 250 unopened heads, only ten were without ants. The greatest number on one head was twelve, the average three or four. Not seldom they creep over the flowers so that the purpose seems not to be to exclude them from these. Experiment establishes the truth of the theory that the ants, here as in so many other cases, are the protectors of the plants — the pigmies, the body-guard of the giants, as it were.

Fifty buds were protected against ants by winding their stems with wool soaked in camphor-solution and oil. Fifty others were left untouched. After four days all of the heads were examined. Forty-seven of the last lot remained; forty-five of them (90 per cent.) had blossomed normally; beetles had eaten the involucral scales of two;

one had been broken by the wind. Forty-six of the protected heads remained. Twenty-seven (only 54 per cent.) had blossomed normally; seventeen were more or less injured by animals. Ants had gained access to two.

Experiments with *Serratula lycopifolia* Vill., gave similar results, so that the usefulness of the ants in both of these cases can hardly be disputed. But both plants are natives of the tropics where ants are most abundant and most wonderfully developed.

There were few ants upon the involucres of *Solidago squarrosa.* Perhaps this very fact accounts for the large number of beetles. But the beetles as well as the numerous other visitors all seemed to suck the nectar without doing injury to the head, and moreover they were observed after all or very nearly all of the flowers were gone, and their visits continued until the coming of cold weather, that is for about two weeks, if my memory is good.

Ludwig says: "In Jurinea the involucral scales are reflexed during anthesis forming a protection to the flowers, while the scales of Serratula are appressed and accordingly, in Serratula the secretion of nectar continues after blossoming." Solidago differs from both, for its involucral scales are reflexed, and the secretion is of long continuance. The plants were grown under unnatural conditions, on an exposed hill at the edge of the Horticultural Garden here at Ithaca. It will be necessary to observe them in their own haunts another year to ascertain surely whether ants are their guests and the champions against their foes.—ALICE CARTER, *Ithaca, N. Y.*

EDITORIAL.

A NEW FEATURE for American expositions has been inaugurated by the World's Fair commissioners. It is proposed to hold a series of congresses in connection with the Fair, to which those interested in the various departments of knowledge are to be invited. These are to be conducted in the same generous spirit which characterizes the other projects of the exposition. The preliminary circulars have been issued, and some of the special congresses are already quite well organized.

Plans for the Botanical Congress are now under consideration. What these plans shall be depends largely upon the botanists of the country. It is much to be desired that a full and hearty expression of opinion be made public through the botanical and other journals, to

serve as a guide for the committee in charge. As it is necessary to push the arrangements as rapidly as possible, those who have words of suggestion or encouragement to offer should not delay to make them known.

The plan, so far as it has been outlined at present, is to invite the botanists of the world to meet at Chicago, sometime during August, 1893, to discuss such matters of interest as may be arranged for beforehand or be brought up at the time, and to enjoy the benefits of personal acquaintance. During the meeting a few stated lectures will be given by distinguished botanists, designed more especially for the general public. Excursions and other means of promoting good fellowship and a profitable time are among the possibilities.

It is hoped to secure for the gathering a truly international character, which will make it not only a notable and pleasant occasion, but give its deliberations a weight and sanction of authority that will do much toward settling disputed questions and advancing the science.

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IN THE September number of *Grevillea* the editor makes the most startling comments on the availability of German mycological works. He says, referring to Brefeld's *Untersuchungen aus dem gesammt Gebiete der Mykologie,* "Mycologists are very limited in number in these islands, and some of these are unable to purchase indiscriminately . . . whilst the number capable of perusing German with ease is considerably less. All those capable of reading and appreciating Dr. Brefeld's works for instance, could be counted on the fingers of one hand!" That, if true, is a lamentable condition. But we hope the statement is too strong.

CURRENT LITERATURE.

Minor Notices.

THE ANNUAL report of 1890 of the state botanist of New York,[1] Chas. H. Peck, contains a list of the plants added to the herbarium during the year (261 species); among which are thirty-six new species of fungi. These are described, and figured on the four plates. There is also a revision of the genus *Tricholoma* which is represented in the

[1] PECK, CHARLES H.—Annual report of the state botanist of the state of New York, made to the regents of the University. From the 44th report of the N. Y. state museum of Natural History. 8vo. pp. 75. pl. 4. Albany: Lyon, state printer, 1891.

state by forty-eight species. The revision is accompanied by full descriptions of these species, with synoptical tables of each of the different groups. The report closes with a list of the plates in a MS. volume regarding the fleshy fungi of Maryland prepared in the course of several years by Miss Mary E. Banning of Baltimore. Miss Banning has made water-color drawings (175 sheets 12×15 inches) of 151 species, accompanied by MS. descriptions and notes, together with a full index. This volume she has presented to the State Museum — a most generous and valuable gift.

VERY FEW researches on the bacteria of the deep sea have been made; indeed the studies of Mr. H. L. Russell, a graduate and sometime Fellow of the University of Wisconsin, which he prosecuted at the zoölogical station at Naples, are almost the first. Through the kindness of the director, Dr. Dohrn, every convenience was afforded him for obtaining samples of water and slime at every available depth in the Gulf of Naples and for investigating the forms so obtained. A large number of soundings were made, up to 1100 meters (3600 ft.). While the observations were not sufficiently numerous to constitute a complete investigation of the subject, the conclusions reached are interesting. Mr. Russell found that the number of micro-organisms present in the sea water appeared rather smaller than those in an equal volume of fresh water. (Upon the latter the author made prolonged study while at the University of Wisconsin.) There do not appear to be any zones of distribution of the bacteria in the water, but the superficial and deepest parts have about the same number. In the slime the number is always vastly greater than in the water above; and their proportion, except perhaps in the littoral zone, is not due to contributions from land but from the growth and multiplication of endemic individuals. Although there are no zones of distribution in the water, in the slime there is a gradual diminution from the maximum near the surface to a depth of 200 m., but from that depth on to 1100 m. (the greatest depth investigated) there is no diminution. The minimum was therefore not reached.

Mr. Russell has brought back with him a large number of cultures of the forms obtained from the deep sea which he intends investigating qualitatively.

DR. C. E. BESSEY publishes as a bulletin of the agricultural experiment station, a list of the native trees and shrubs of Nebraska. The

[1] RUSSELL, H. L.—Untersuchungen über in Golf von Neapel lebende Bacterien. Separat-Abdruck aus der Zeitschrift für Hygeine und Infectionskrankheiten, Band XI. 1891. 8vo. pp. 165—207. pl. XII. and XIII. 1891.

list includes 125 species, about equally divided between the two. A discussion of the distribution of the woody plants of the state at the close is interesting. Dr. Bessey thinks that this distribution shows that the woody plants have nearly all come up the Missouri bottoms and spread west and north-west. Those found only in the western part have undoubtedly come from the Rocky Mountains and have spread eastward to their present limits.

The nomenclature of the list shows a wide departure from that of the Manuals. Justifiable as many of these departures are, they seem out of place in such a publication as the present, because they certainly interfere with its usefulness for those not specialists.[1]

If COLLECTORS are not properly informed as to how to collect plants it will not be for want of instructions. Two months ago we noticed Prof. Penhallow's booklet; now we have before us a pamphlet issued by the National Museum and prepared by Mr. F. H. Knowlton.[2] It contains directions for collecting all sorts of plants, as well as for caring for them after they are collected. In its preparation the author has drawn freely on Bailey's Collector's Handbook and the herbarium number of this journal (June, 1886, for which there was such a demand that the extra edition was soon exhausted). In many respects the present directions are better than their predecessors; it extends their range by giving directions for the collection of fossil plants. Certainly now if one puts together the instructions to be found in every text book and in almost every flora, those of Bailey, Penhallow and Knowlton, he will have all the knowledge that writing can give him of how to preserve plants. *Jam satis!*

OPEN LETTERS.

A section of botany in the American Association.

The thought of having a section for the botanists in the A. A. A. S. should be very inspiring to all who have at heart the thorough study of plant life in America. All admit that Section F is now crowded with members and papers, and doubtless many are deterred from taking part in the sessions from lack of opportunity. At the last

[1] BESSEY, C. E.—Preliminary report on the native trees and shrubs of Nebraska. Bulletin 18 of the Ag. Exp. Sta. of Neb., vol. iv. art. iv. pp. 171–202.

[2] KNOWLTON, F. H.—Directions for collecting recent and fossil plants. Part B of Bulletin of U. S. Nat. Mus. no. 39. 8vo. pp. 46. figs. 10. Washington: Gov. Printing Office. 1891.

meeting numerous papers were passed without comment or discussion that the programme might be carried out.

The work of the section has naturally divided itself into two groups, namely, that pertaining to animal life, and to botany. In order to gain more time and draw together more closely those who are interested in particular branches, clubs have been formed. Thus the entomogical and botanical clubs have arisen and grown into features of the week of as much importance as the section and more perhaps to the younger members. These clubs should, and doubtless will be continued. In the section itself for years there has been an attempt on the part of the programme committee to group the subjects so that zoölogists and entomologists have had a half day assigned them, alternately with the botanists. This has virtually broken up the continuous attendance of members upon the sectional meetings and excursions or other events are indulged in by the party not upon the programme. Perhaps to our shame, this has been particularly true of the botanists who have sometimes left the zoölogists with a depleted but more homogeneous and attentive audience. Also within the past few years the plan of having time assigned for a series of connected papers upon one or more of the branches of science coming under the present scope of the section has still further differentiated the work. As Section F now stands its sessions are largely an alternation of groups of subjects with an audience that shifts with the programme.

A notice of an amendment to divide Section F is therefore well founded; the division is very natural and one that, in fact, has already been made, so far as arranging the programme by grouping the subjects and by the work of the clubs will permit it. In short, it has gone as far as it can save by a division of the section itself.

The contemplated division will bring many gains without corresponding losses. Time will then be offered for thorough sectional work upon the two large and growing fields of biological science, instead of the rapid reading of papers as at present, followed by little or no discussion before a half interested audience.

With a Section of Botany, for example, officers can be selected who will be interested in all subjects presented, a condition that does not always obtain under the present arrangement, to say nothing about the difficulty that may now arise as to the proper apportionment of the official plums among the aspirants for honors.

If we believe in the principle of division of labor and specialization, in short in the theory of evolution in its broad and best sense, we cannot but feel that the proposed step is in the direction of advance, and realize that the last few meetings of Section F indicate clearly that the time to take the step forward is at hand.

The best way to make the importance of a division still more emphatic is for every student of the biological sciences to come, if possible to the Rochester meeting with a large number of full papers, and strive to have as many as possible read and discussed in Section F, the balance of shorter ones to be considered as best they may at the clubs. As a section of Botany is asked for, let the botanists in particular show by their works, their faith in the reasonableness of the demand.— Byron D. Halsted, *Rutgers College.*

The Baltimore oriole mutilating flowers.

The interesting note of J. Schneck in regard to the oriole piercing the flowers of the trumpet-vine for the nectar reminds me of a note which I sent the *American Naturalist*, and printed in 1869, on p. 380. In that case the Missouri currant (*Ribes aureum*) was the plant. The fact of their piercing large numbers of flowers for at least two seasons in the village of Union Springs, Cayuga county, was well established. Honey bees gleaned freely of the honey through these holes, as the corolla is too long for them to reach it through the tube.— W. J. BEAL, *Agricultural College, Michigan.*

Misconceptions of botanical homologies.

I had occasion in the June number of the GAZETTE, last year, to call attention, on pp. 178, 179, to the vicious confusion in the terminology of the spermaphytic flower. Two melancholy examples of this confusion have just come to my notice and I cannot forbear referring to them. One is on pp. 162, 163 of Warming's *Haandbog i den systematiske Botanik* (German translation), where under the bold headline *Die ungeschlechtliche Generation der Kormophyten* occurs considerable talk about "eingeschlechtig," "zweigeschlechtig" and "hermaphrodite" flowers, thus affording an exquisite illustration of how easy it is to classify black, blue and green under the generic head of pale yellow.

The other example is sadder, for it is the cause of a serious blunder. It is in Geddes and Thompson's "Significance of Sex," a very suggestive and admirable work, after reading which one can not but regret that it apparently did not occur to the authors to give particular attention to botany as one of the biological sciences. But this is an ordinary oversight. On p. 48, where the discussion of nutrition as influencing sex is going on, we have a couple of tolerable pictures of the diclinous, asexual, pollenar and ovular plants of *Lychnis diurna* figuring as the "male and female flowers;" and, basing their remarks upon such a failure to comprehend plant homologies, the authors observe that "the botanical evidence, though by no means very strong, certainly corroborates the general result that good nourishment produces a preponderance of females." It is just here that Geddes and Thompson, misled by the false terminology which botanists, to their discredit, still suffer to continue, lose the opportunity of making a strong point along their line of research.

Let us see what the condition really is in plants of the type of *Lychnis*. The pollen grain or microspore produces a one or two-celled male plant — the pollen-tube: the megaspore or embryo-sac produces a seven-celled female plant. What was the origin of the two sizes of spores? In short this: spore-mother-cells in certain sporangia divided internally into four spore-cells, each of which developed to maturity and was a pollen-spore. In other sporangia the spore-mother-cell formed four nuclei and the potentially *four*-spored contents produced only *one* spore — the embryo-sac — *because one of the cell-nuclei reabsorbed the others, and one cell united to itself the three sister cells.* Where could there be found a more instructive example of high spore-nutrition tending to develop a female plant? It is superb. One might challenge the zoölogist to bring forward any evidence

clearer than this. In fact it is in the plant world that we must look for much of our testimony along the more diffcult lines of biological science. And it is the duty of botanists to clear up the confusion of their terminology, especially along those lines which are subject to so great popular misapprehension. It should not be possible, even for the casual reader of botany, to encounter such contradiction and error as clusters about the spermaphytic plants, imbedded in a misleading terminology.— CONWAY MACMILLAN, *University of Minnesota, Minneapolis.*

NOTES AND NEWS.

THE VENERABLE curator of the botanical museum at Berlin, Friedrich Karl Dietrich, is dead at the age of 85.

DURING THE year 1890 42,646 specimens were added to the Herbarium of the British Museum, according to the report just published.

MR. A. S. HITCHCOCK, of the Missouri Botanical Garden, has been appointed Professor of Botany in the Agricultural College of Kansas at Manhattan.

MR. P. H. ROLFS, recently connected with the Iowa Agricultural College, at Ames, has been appointed botanist and entomologist of the Florida Agricultural Experiment Station at Lake City, Fla.

MR. WILLIAM WEST has a paper in the December number of the *Journal of Botany* on the freshwater Algae of Maine, in which three new species and several new varieties are described. There are also notes on other species of the collection.

DR. FR. ORTLOFF of Coburg (Thuringia) Germany, has just issued a series of photographic reproductions of the stem-leaves of Sphagnum which are of so much diagnostic importance in the discrimination of the polymorphic species of this genus. The series contains 63 plates.

PROF. L. H. BAILEY has been appointed special agent of the United States Weather Bureau to make a report upon phenology, and desires reference to all records upon the relation of climate to the times of blooming, fruiting, leafing, etc., of plants. He may be addressed at Ithaca, N. Y.

PROF. R. E. CALL has given an account of the silicified woods of E. Arkansas in the *American Journal of Science* (Nov. 1891), in which he concludes that they are all Tertiary (Eocene), are silicified lignite, and are as yet of no taxonomic value in determining relative ages in the Tertiary series.

THE MOSS herbarium of the late Dr. S. O. Lindberg has been acquired by the University of Helsingfors. Exclusive of duplicates and of numerous exsiccati the collection contains 5,046 species represented

by 47,858 specimens. It is especially rich in northern Hepaticæ, and is remarkable for the completeness, abundance and critical elaboration of the material.

PROF. W. W. BAILEY writes: "One of my students called my attention the other day to a *Linaria* raceme in which the flowers were all spurless. Peloria is not infrequent this autumn." And again: "As my colleague, Mr. Bennett, was drying some capsules of *Ceanothus* in the sun. for the purpose of securing the seeds, he noticed, and showed me, that these parts exploded with much violence, ejecting the seeds."

A FOUR PAGE supplement to the "Analytic Keys to the genera and species of North American mosses" has been prepared and issued as separates from the 8th volume of the Transactions of the Wisconsin Academy. It contains additions and corrections and may be obtained of the author (C. R. Barnes, 712 Langdon St., Madison, Wis.) *gratis*, by sending a request accompanied by a 2-cent stamp. It will be of no value except to those who have a copy of the Keys.

THE SERIES of *Hepaticæ Americanæ exsiccatæ* has been issued by L. M. Underwood and O. F. Cook, in sets of two decades annually since 1887. Many rare and previously undistributed species have been sent out, and others are to follow, including specimens from British Columbia, Florida, Cuba and Mexico. Decades XI and XII are now ready for distribution. Preceding issues are all exhausted with the exception of decades IX and X, of which a few sets are still on hand. Correspondents should now address Dr. Underwood at Greencastle, Ind.

IN VIEW OF a contemplated special investigation of the genus Astragalus (including Phaca, Diplotheca, Homalobus, and Podolotus), Mr. E. P. Sheldon, Assistant in Botany at the University of Minnesota in Minneapolis, desires specimens of this genus from all parts of the world. In exchange he offers either fungi or flowering plants from the valley of the Minnesota river, which derives a peculiar interest from its position as the central drainage system of the continent of North America. Plants may be sent to him in care of the university, and will be promptly acknowledged.

THE HERBARIUM of Indiana University was established upon the election last April, of Professor John M. Coulter, as President. In addition to private material already in the possession of Professor Coulter, a liberal appropriation for the purchase of plants was made. All the well-known collectors of phanerogams and pteridophytes were asked to furnish as complete sets of their collections as possible, and these purchases now amount to over 15,000 species of North American plants. A very valuable library of reference books has also been secured. It is expected that the collection of books and plants will increase as rapidly as material for purchase or exchange becomes accessible. Mr. Henry E. Seaton has been appointed curator.

A NEW JOURNAL of forestry, *Forstlich-naturwissenchaftliche Zeitschrift*, is to be begun with the year. It is to be the organ for the Munich laboratories of forest botany, zoology, chemistry and meteorology, under the editorial management of Privat-docent Dr. Carl von Tubeuf of the University of Munich. Of course it has the support

and contributions of Dr. R. Hartig who is to continue in this journal the "Untersuchungen aus dem forstbotanischen Institut" he ceased to publish in 1883. Drs. Ebermayer, Pauly and Baumann of Munich are to aid, and the journal has the promise of coöperation from many others who are learned in forestry. Among these we notice but one from this country, Mr. B. E. Fernow, chief of the division of forestry of the Agricultural Department.

Dr. Paul Knuth seeks to explain why many flowers, without apparently very attractive coloration are so readily found by insects. *Sicyos angulata*, for example, was surrounded by swarms of insects, while at the same time other plants in the botanic garden at Kiel were neglected. The ethereal oil secreted by the glands of the flowers, stem and leaves, which affect the senses of man so slightly, may be partly the cause of the attractiveness of this plant to its insect visitors. But he finds also that the greenish white flowers are probably much more striking to insect eyes than to our own, on account of the ultra-violet rays which lie beyond the range of our vision. That such rays are reflected by these flowers he showed by their effectiveness upon photographic plates with short exposures. They are photographically as active as white flowers, while the intensity of light reflected (photometric activity) is only one-third that of white flowers. We have here apparently an analogy with those sounds which can be heard by insects, but which are beyond the range of the human ear.

Mr. John B. Leiberg writes from northern Idaho: "My list of mosses from this region now foots up 304 species and varieties. Many of these are as yet undetermined. Some have only turned up as fragments amongst other mosses. . . . The magnitude of western bryology is utterly unappreciated by bryologists of this country unless they have been here in person and seen it with their own eyes. Most of my observations have been limited to the western slope of the Bitterroot mountains. There are 250 miles of this range extending north and south, and the width of the western slope varies from 30 to 120 miles. There are millions of canyons and ravines in this tract of country. Of all the thousands I have seen into I never saw two where exactly the same climatic conditions prevailed. It is a fact easily proved that changes on climatic conditions mean changes in both the vegetative and structural aspect of mosses more quickly than in any other group of plants. . . . It is an impossibility for collectors to obtain all the various aspects of any species for generations to come, so our knowledge of the western mosses will come slowly and painfully, for collecting mosses among these mountains is no holiday excursion."

Dr. Fr. Krasser recommends the following methods for preparation of permanent mounts of aleurone grains to show the ground substance, crystalloid and globoid differentially stained.

I. Picro-eosin method. Fix the section with picric acid dissolved in absolute alcohol; remove the excess by washing with absolute or a high grade alcohol; stain with eosin dissolved in absolute alcohol; partially decolorize wit absolute alcohol; clear with clove oil; mount in Canada balsam dissolved in chloroform. The course of the stain-

ing, which is completed in a few minutes, should be watched under the microscope, as should also the toning down. The most successful preparations show the ground-substance dark red, the crystalloid yellow with sharp contours, and the globoid nearly colorless to reddish.

II. Picro-nigrosin method. Place the section in alcoholic-picro-nigrosin (a saturated solution of picric acid in absolute alcohol+nigrosin approximately to saturation) in which it is allowed to remain until the ground-substance of the aleurone grain shows a blue coloration. This is to be determined by observations at intervals with the microscope, the specimens being put into absolute alcohol temporarily. Wash with absolute alcohol; clear on the slide with clove oil; mount in Canada balsam, removing the clove oil with filter paper. The most successful preparations show the ground substance blue, the globoid colorless, and the crystalloid yellowish green and sharply limited.

THE difficulty of keeping Irish potatoes in edible condition in late spring is well known to housekeepers, farmers, and merchants. Professor Schribaux of the National College of Agriculture of France has recently devised a very simple, cheap, and successful method by which he has been able to preserve potatoes in edible condition for over a year and a half. This process has been adopted by the French government for preserving potatoes for the army. The French Minister of Agriculture publishes the details of the process in the official *Bulletin du Ministére de l'Agriculture* for March, 1891. The following is a translation of the essential part of the scheme. The method of preservation consists in plunging the tubers, before storing them away, for ten hours into a two per cent. solution of commercial sulphuric acid in water, two parts of acid to 100 parts of water. The acid penetrates the eyes to the depth of about one-fortieth of an inch, which serves to destroy their sprouting power; it does not have any appreciable effect upon the skin of the potatoes. After remaining in the liquid ten hours the tubers must be thoroughly dried before storing away. The same liquid may be used any number of times with equally good results. A barrel or tank of any kind will do for the treatment. The acid is so dilute it does not affect the wood. Chemical analysis shows that potatoes treated by this process are as nutritious and healthful after eighteen months as when freshly dug; but they are of course worthless for planting. Attention is called to this method by Gerald McCarthy, N. C. Experiment Station, Raleigh.—*Science*, Nov. 13.

IN THE *Revue Bryologique* (n. 6, 1891) appears a synoptic table of the species of the genus *Fontinalis* recognized by M. Jules Cardot in his recent revision of the family Fontinaleæ. which he hopes to publish early this year. The North American species are as follows according to M. Cardot:

§ I. Tropidophyllæ.

F. antipyretica L. (N. Am.)
- var. gigantea Sull. (N. Am.)
- var. Californica Lesq.—(Calif.)
- var. Oregonensis R. & C.—(Oregon.)
- var. rigens R. & C.—(Vancouver: Wash.)
- var. ambigua Card.—(Oregon.)

*F. Kindbergii R. & C.—(Vancouver: Oregon: Idaho.)
*F. Neo-Mexicana S. & L.—(Rocky Mts.: N. M.: Idaho: Calif.: Wash.: Vancouver.)
*F. Columbica Card.—(Br. Columbia.)
F. chrysophylla Card.—(Utah.)

§ II. Heterophyllæ.

F. Howellii R. & C.—(Oregon.)
F. biformis Sull.—(Ohio: Wisc.)
F. disticha Hook. & Wils.—(La., Ala.)
F. Renauldi Card. = *F. Sullivantii* Aust. non Lindb.; *F. Lescurii*, var. *ramosior* Sull.?—(New Jersey.)

§ III. Lepidophyllæ.

[F. squamosa L.]
*F. Delamarei R. & C.—(Miquelon.)
*F. Dalecarlica B. & S.—(Canada: Eastern States.)
F. Novæ-Angliæ Sull.—(Eastern States.)
*F. Cardoti Ren.—(Virginia.)
F. involuta R. & C. = *F. squamosa* Drumm. Musci-Am. II.n.152.—(La.)

§ IV. Malacophyllæ.

F. hypnoides Hartm.—(N. Am.)
*F. nitida Lindb. & Arn.—(Br. Columbia.)
*F. tenella Card.—Idaho.)
F. Duriæi Sch.—(California.)
F. Lescurii Sull.—(excl. var.)—(Canada, U. S.)
F. flaccida R. & C.—(La.)
F. Sullivantii Lindb. = *F. Lescurii*, var. *gracilescens* Sull.—(U. S.)

§ V. Stenophyllæ.

F. dichelymoides Lindb.—(Minn.)

§ VI. Solenophyllæ.

F. filiformis S. & L.—(Ky.)
F. Langloisii Card.—(La.)

F. maritima Müll. and *F. mollis* Müll. (Washington) are both unknown to M. Cardot. North America has 24 species and subspecies out of the 52 known.

*Subspecies.

SCRIBNER'S MAGAZINE for January begins the sixth year and eleventh volume of this periodical, which now announces a circulation of more than one hundred and forty thousand copies monthly. The plans for the new year include, beside the more purely literary contents, remarkable series on the Poor in the World's Great Cities; Important Historical Moments, by eminent men who took part in them; Out-of-Door Papers; occasional Railway articles on Rapid Transit, Australian Railways, Speed in Locomotives; on important Waterways, the Nicaragua Canal, and the water-route from Chicago to the Ocean; also travel, exploration, and abundant fiction, including the notable serial "The Wrecker," by Robert Louis Stevenson and Lloyd Osbourne.

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The catalogue of plants growing within 100 miles of New York, published in 1888, may still be had at $1.00 a copy.

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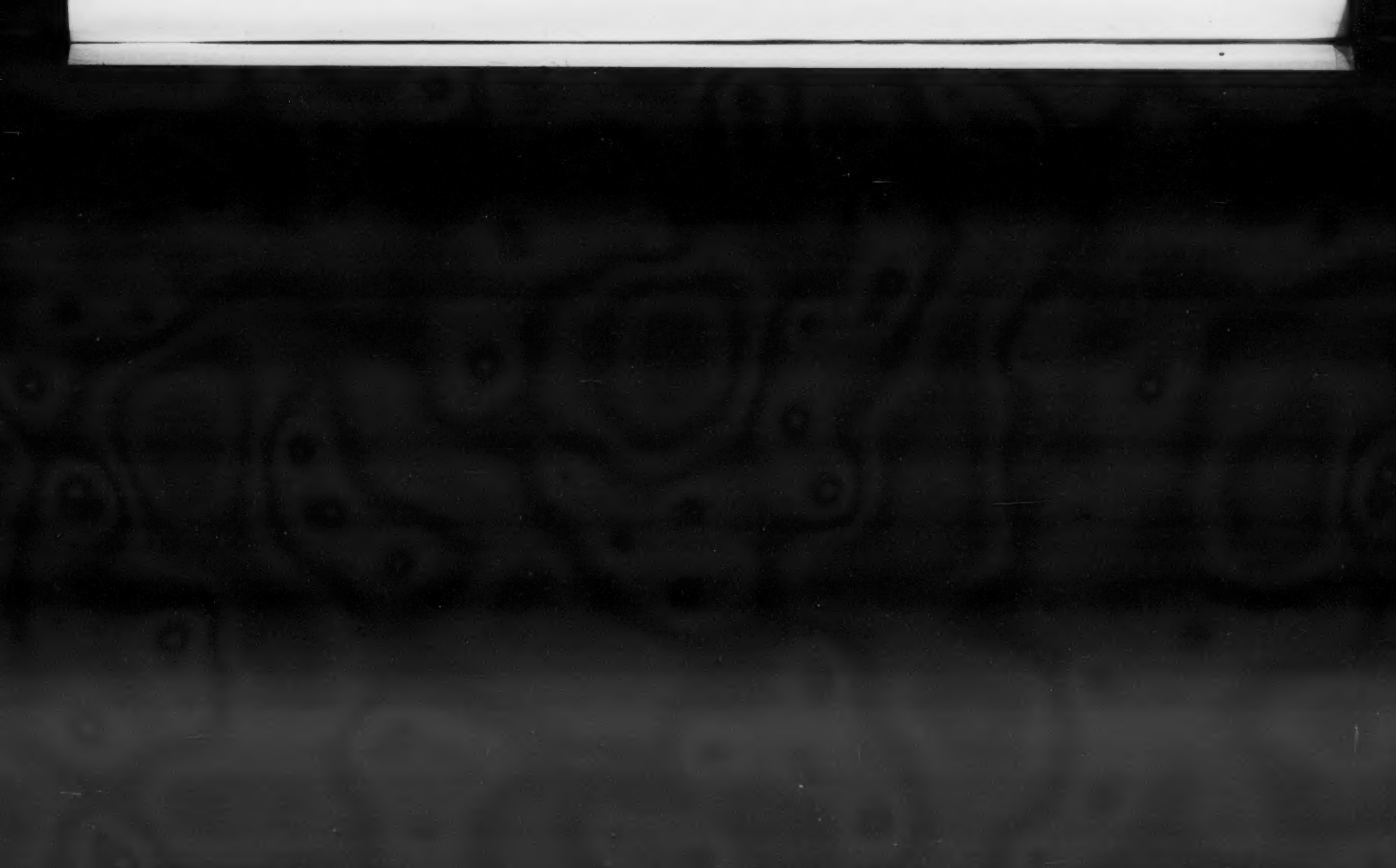

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Although promising but 24 pages monthly, the issues have averaged about 30. The illustrations have been ample, averaging more than two and a half full plates for each number, with many cuts printed in the text. These have been of the best quality of photo-engraving and lithographic work.

FOR 1892.

The make-up and conduct of the journal will remain essentially as heretofore. The secure financial basis which has now been reached justifies the publishers in announcing

AN INCREASE IN SIZE

from 24 to 32 pages monthly, with the probability that, as in the preceding years, the number of pages printed will exceed the number promised.

The now familiar appearance of the journal will not be altered by any marked changes, although a few minor ones will be introduced, the most important being the substitution of heavier paper.

In order to meet more fully the demand for information regarding recent researches by foreign botanists, arrangements have been made to present a series of

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upon the pages of the journal, without undue favor toward any. The journal is devoted to **botany in its widest sense.** That its aim in this regard has heretofore been reasonably well attained can be seen by reference to the table of contents for the last year; but it is hoped that contributors and readers will bear in mind that any apparent or actual omissions are not due to editorial disfavor.

With the beginning of 1892 the publication office changes from Crawfordsville to Bloomington, Ind. This is the second change in the sixteen years of the existence of the journal. It was published at Hanover, Ind., from its beginning in 1875 to 1879, and at Crawfordsville from 1880 to the present time.

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